

The Ecological Preference of Two *Avicennia* Species to the Environmental Parameters in the Mangrove Belt of Wulan River Demak

Ekopreferensi Dua Jenis *Avicennia* Terhadap Parameter Lingkungan Di Tegakan Bakau Muara Sungai Wulan Demak

Joudy R.R. Sangari¹

A b s t r a k

Studi mengenai ekopreferensi dan dua jenis mangrove (*Avicennia marina* dan *A. alba*) dilakukan di tegakan mangrove muara sungai Wulan, Demak. Tujuan penelitian ini diarahkan untuk melihat kemampuan ekopreferensi *A. marina* dan *A. alba* terhadap salinitas, jenis sedimen dan kandungan air. Data vegetasi diperoleh dengan menggunakan transek garis yang dikombinasikan dengan cara kuadrat yang dimodifikasi dari Cox (1967) dan Mueller-Dumbois & Ellenberg (1977). Dua stasiun pengumpulan data vegetasi ditentukan secara horisontal dari garis pasang terendah sampai garis pasang tertinggi. Pengukuran parameter lingkungan dilakukan pada transek yang ada dan tanah sampel dianalisis untuk melihat fraksi tekstur. Hasil analisis menunjukkan bahwa dalam hal keragaman vegetasi, tegakan mangrove yang ada di muara Sungai Wulan miskin dalam hal komposisi jenis dibandingkan dengan tegakan mangrove yang ada di sepanjang pantai utara Jawa Tengah. Studi ini juga menunjukkan bahwa kehadiran *A. marina* cenderung menjadi species pelopor dibandingkan dengan *A. alba*. Diduga hal ini disebabkan oleh kemampuan *A. marina* untuk beradaptasi pada kondisi salinitas dan tipe tanah yang marginal.

Kata kunci: Bakau, ekopreferensi, *A. marina*, *A. alba*, Muara Sungai Wulan

A b s t r a c t

Study on ecological preferences of two *Avicennia* species was carried out in Wulan River, Demak, Central Java. The study was aimed at revealing the eco-preference toward salinity, sediment types and water content. Vegetation data were collected by implementing line transect approach combined with quadrat methods modified according to Cox (1967) and Mueller-Dumbois & Ellenberg (1977). Two sites for vegetation data collection were set horizontally from High Tide Mark toward Low Tide Mark. All ecological parameters were measured in situ on the established transects. The results showed that in term of mangrove species diversity this area is low or marginally poor compared to other mangrove belts along the northern coast of Central Java. The study also showed that the two *Avicennia* species are the pioneer species. These two species of *Avicennia* are adaptable to the salinity and soil types that are poor in term of nutrients content.

Key word: mangrove, ecological-preference, *A. alba*, *A. marina*, Wulan River estuary

¹ Staf pengajar Fakultas Perikanan dan Ilmu Kelautan UNSRAT Manado

INTRODUCTION

Mangrove ecosystem of Indonesian islands covers a wide area along the coast and the mouth of rivers. Based upon the data available from the Forestry Department, the total size of mangrove area in Indonesia is 4.25 million ha covering only 3.98 percent of the country forest. In economical senses, such size of the forest is hardly significant considering the economical role of terrestrial green forest. In spite of its minor role to the economic sense, it has an important role in a coastal zone ecosystem. Martusubroto and Naamin (1977) had reported that the total production of prawn fishery showed a positive correlation to the total mangrove area.

Northern coast of Central Java has its characterized features in comparison to other Indonesian coastal areas, that is in term of: the population density, the presence of huge areal of brackish water pond, and the limitation of mangrove area. According to Rahardjo *et al.* (1980) and Hendrato (1986) the information regarding the distribution of vegetation and the influencing environmental factors are still lacked. Therefore this study was designed to determine the possibility of the ecological preferences in *A. marina* and *A. alba* to the environmental parameters and also the effects of those environmental parameters in controlling the distribution of vegetation within certain zonation. One of the mangrove characteristics is the zonation pattern of the vegetation observed in coastal line. Therefore organisms in that system ecologically have their own niche (Kartawinata *et al.* 1979) as shown on the variation developed within the communities and on various composition of vegetation from place to place (Chapman 1976. Lear & Turner 1977 and Hendrato 1983).

The ecological preference among the mangrove species, according to Steenis (1958) in Kartawinata *et al.* (1979) is caused by

the combination of factors such as: soil type, salinity, the resistance to current and wave, and seedling condition to grow. Similar argument was reported by Chapman (1976) and Lear & Turner (1977).

A specific preference to soil type was observed on genus *Rhizophora* Alrasjid (1977) observed that *R. mucronata* was commonly found in clay soil along the coastal area while *R. stylosa* was found in sandy and corally soils. The same condition was reported by Kartawinata *et al.* (1979).

As a controlling factor on the zonation development, salinity was found to be significant influencing the presence and growth of *Rhizophora*. Varied salinity concentrations lead to the variation in species. Despite the fact that all mangroves species can tolerate various salinity concentrations, it was observed that there are some species which do not need salt to grow (Richards 1964 in Sukardjo 1984).

METHODS

Since this study was conducted in the field, a pre survey was conducted to get some information on both local topography and hydroceanography data led by secondary data. Data on vegetation were collected using 5 x 5 m quadrat modified from Cox (1967), Mueller-Dumbois & Ellenberg (1977) and Soerianegara and Inderawan (1982). Transects of 100 m were laid horizontally from the low tide mark (LTM) to the high tide mark (HTM) on the mangrove belt of Wulan river estuary. Vegetation samples were identified in the field and confirmed at Coastal Zone Ecodevelopment Laboratory, UNDIP, Jepara. Vegetation parameters of density, dominance, frequency and important value index; were calculated using the formula suggested by Cox (1967), and Muller Dumbois & Ellenberg (1977).

Soil samples of 20 x 20 x 20 cm were collected concurrently from the sites along the transect line. A laboratory

analysis of texture fraction and water content was done at Soil Mechanics Laboratory, the Faculty of Civil Engineering, UNDIP.

RESULTS AND DISCUSSION

Vegetation parameters

The Wulan river estuary is situated in the district of Demak, in the northern coast of Central Java. The illustration of Wulan river estuary is shown in Figure 1. In a successive term, this mangrove belt has been considered to be in a secondary stage.

This study was able to identify six mangrove species which are *Avicennia alba*, *A. marina*, *Acanthus ilicifolius*, *Cynometra ramiflora*, *Rhizophora conjugata*, and *R. mucronata*. From those six members of mangrove vegetation community, *A. ilicifolius* and *C. ramiflora* are bushes. Compare to the other mangrove area along the northern coast of Central Java, this area is poor in term of vegetation composition (Rahardjo *et al.* 1980 and Hendrato 1983, 1966). Table 1 shows the analysis for vegetation parameters determined in this study.

Table 1. Analyses of vegetation parameters in the mangrove community of the Wulan river estuary

| Species | D | Dr | Dm | Dmr | F | Fr | IV |
|-----------------------------|-----|--------|-------|--------|-------|--------|---------|
| <i>Avicennia alba</i> | 92 | 14.024 | 0.025 | 10.865 | 0.533 | 19.049 | 43.938 |
| <i>Avicennia marina</i> | 372 | 56.704 | 0.020 | 52.151 | 0.933 | 33.345 | 142.209 |
| <i>Acanthus ilicifolius</i> | 44 | 6.707 | 0.009 | 1.263 | 0.333 | 11.901 | 19.209 |
| <i>Cynometra ramiflora</i> | 12 | 1.829 | 0.001 | 0.435 | 0.133 | 4.769 | 7.033 |
| <i>Rhizophora conjugata</i> | 96 | 14.634 | 0.056 | 24.337 | 0.599 | 19.049 | 58.020 |
| <i>Rhizophora mucronata</i> | 40 | 6.098 | 0.025 | 10.949 | 0.333 | 11.901 | 11.948 |
| | 656 | 100.00 | | 100.00 | | 100.00 | |

Note:

0 = Density Dr = Relative density IV = Important Value Index

Om = Dominance Dmr = Relative dominance

F = Frequency Fr = Relative Frequency

Among the species *Avicennia marina* gives the highest density (372 trees per ha). This explains the ability of *A. marina* in occupying the space. The higher its ability to occupy the area the wider its chance to develop in the ecological zone. The highest frequency *A. marina* suggests that compared to *A. alba*, the former species is superior in occupying the ecosystem (Table 1). Besides, there has been no information whether these two species do share the same niche.

The summation of relative density, relative dominance, and relative frequency shows the important value index. Furthermore the important value index shows the ability of vegetation to adapt the interacted of environmental factors. Referring to this index, *A. marina* shows the highest value as well compared to *A. alba* and other species. The important value index of *A. alba* is lower than that of *R. conjugata* and this might be explained by the bigger trunk of the latter species.

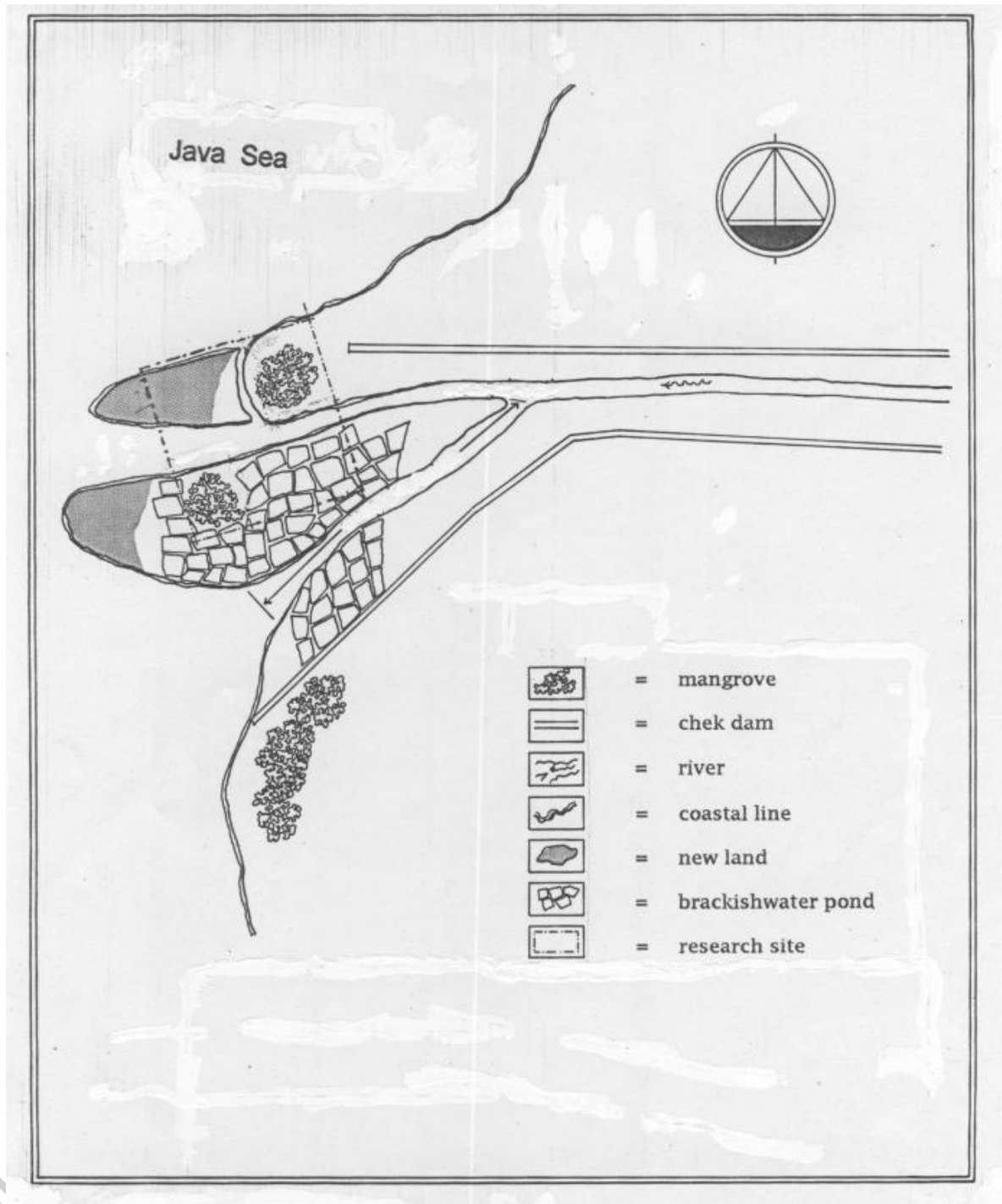


Figure 1. The Illustration of Wulan River Estuary

Overall, *A. marina* is found dominant in the mangrove belt of Wulan river. All parameters revealed that the adaptive performance of *A. marina* which has the ability to grow in a

marginal condition is influenced by the open water. Conversely, the distribution of *A. alba* was found to be limited only to the area that had been occupied by the pioneer species of *A. marina*.

The fact that seedlings of *A. marina* were found densely at the open water of Wulan river estuary has been merely caused by its high regenerative ability being a pioneer species. With a relatively calm water, the seed distribution will not be too far from the coastal area. Consequently, the seeds are able to grow to seedlings as was also found by Hendrato (1983) in Morodemak area.

Environmental Parameters Table 2 shows the overall results of the environmental parameters. The range of water content is 60.21-76.57 %. Such percentage is likely to have a

correlation to the clay and silt content of the soil substrate. It was assumed that the distribution pattern of *A. marina* was influenced by the clay and silt content as well as water content of the soil. Study done by Hedrato (1983) on the mangrove ecosystem of Morodemak has proven that the presence of *A. marina* is correlated positively with both water content and silt concentration. Besides, it has been known that *A. marina* can withstand salinity as high as 90 ‰. The species also has pneumatophore roots that are useful in respiration process (Chapman, 1976).

Table 2. Environmental parameters of mangrove belt of Wulan river estuary

| PARAMETER | TERRESTRIAL | HTM (HighTide Mark) | LTM (LowTide Mark) |
|-------------------------------|-------------|---------------------------|--------------------------|
| Ground water pH | 7.0 | 6.5 | 7.0 |
| Soil pH | 7.5 | 8.0 | 6.5 |
| Water content (%) | 60.21 | 66.90 | 76.57 |
| Salinity (o/oo) | 2.0 | 7.0 | 15.0 |
| Soil temperature (°C) | 31.0 | 31.0 | 29.0 |
| Ground water temperature (°C) | 28.0 | 28.0 | 27.0 |
| Water current (m/second) | 0.35 | 0.50 | 0.55 |

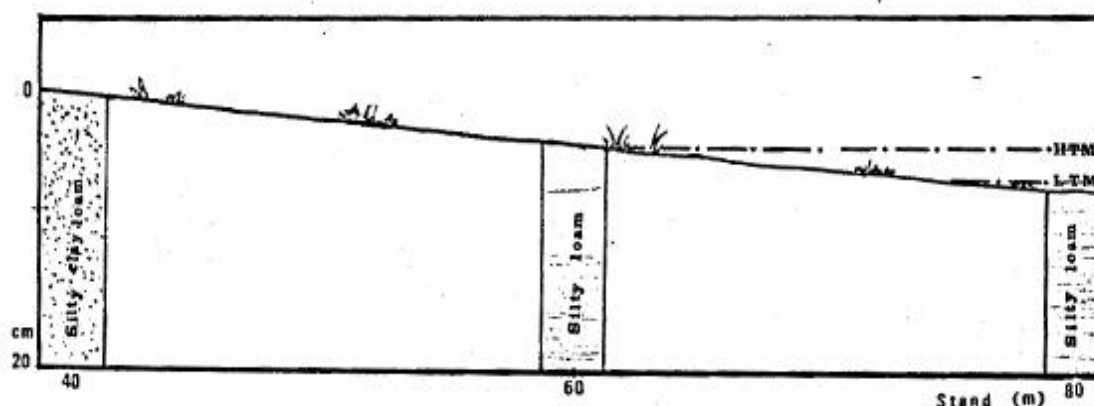


Figure 2. Vertical profile of the top soil on 20 cm depth

The salinity value of 2.0 -15.00 o/oo is likely to be influenced by the minimum tidal spring at coastal areas due to the sedimentation occurred on the river estuary. Possibly, this is also caused by the huge volume of the inland freshwater. Salinity influence is clearly observed on the distribution of *Avicennia marina*, especially on the seedlings. Seedlings that were denser at the lower tide may obviously indicated a high tolerance ability of this vegetation to salinity.

Based on the distribution of sand, silt, and clay fractions it was found that the top soil texture of 20.0 cm depth was ranging from siltyclay loam to silty loam. The sand content

tends to increase from the HTM (High Tide Mark) to the LTM (Low Tide Mark) while the silt tends to decrease. Vertical profile of the soil type was shown in Figure 2.

Analyses of environmental parameters (as shown graphically in Figure 3) demonstrate the roles of salinity, soil type and water content on the zonation and distribution of *A. marina*, which greatly differs from distribution and zonation of *A. alba*. This result was also confirmed by Hendrato (1983) in his study in Morodemak.

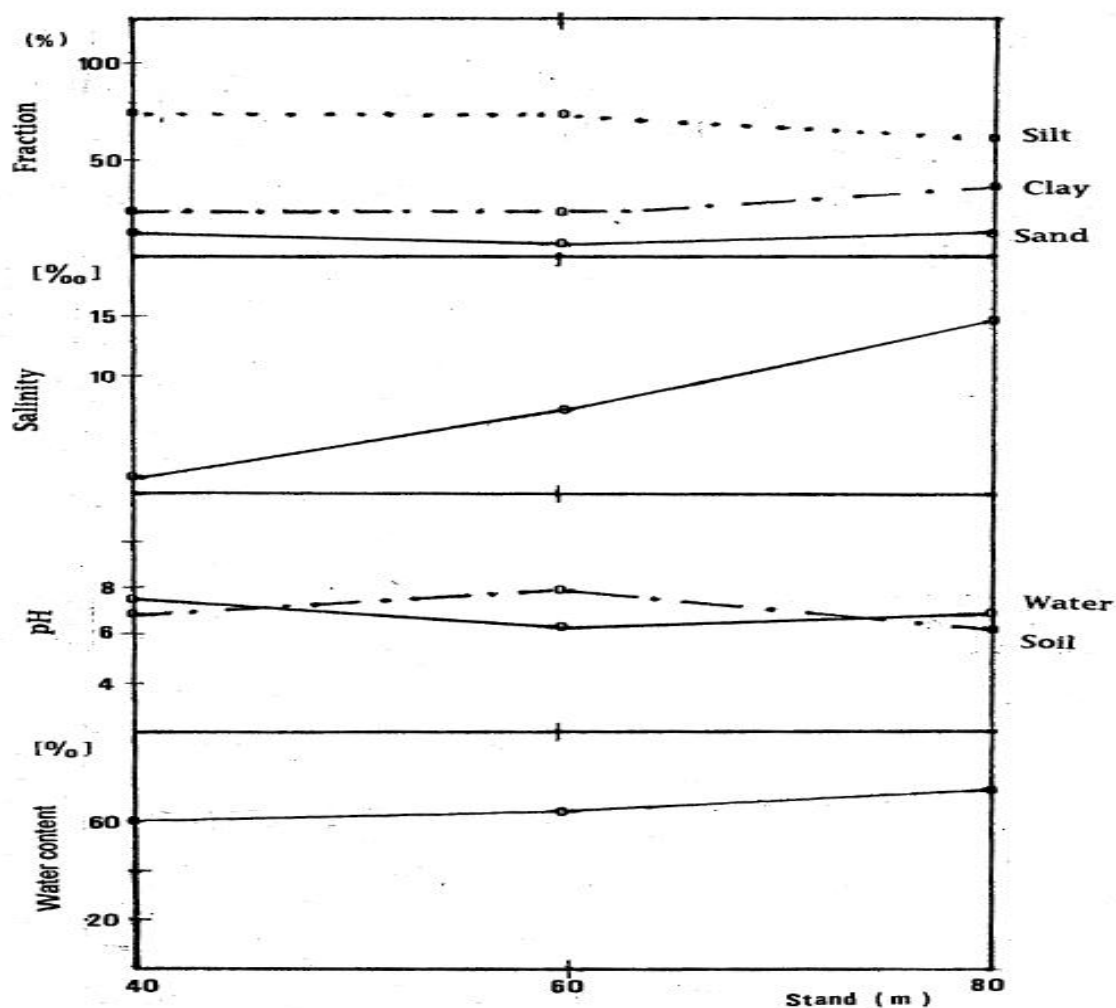


Figure 3. Environmental factors effecting *A. marina*

CONCLUSION

Based upon this study, it can be concluded that the presence of *A. marina* is strongly influenced by environmental factors such as salinity, soil type and water content. The distribution pattern of this species supports its presence which proves its pioneering role in the development of a new mangrove belt. The effect of other environmental factors than salinity, soil type and water content, need to be furtherly studied in relation to the distribution and zonation of mangrove ecosystems.

REFERENCES

- Alrasjid, H. 1977. Kelestarian hutan mangrove. Seminar Kedua Perikanan Udang, Jakarta. 14 hal.
- Chapman, V.J., 1976. Mangrove vegetation. By Strauss & Cramer GmbH, Leutemausen . 483 pp.
- Cox, G.W., 1967. Laboratory manual of general ecology. WM.C Brown Company Publishers, Iowa. 165 pp.
- Hendrato, B. 1983. Aspects of the ecology of salt marsh and mangrove ecosystems. Department of Plant Biology, University of Newcastle upon Tyne. MSc thesis 234 pp.
- _____. 1986. Jenis dan penyebaran vegetasi mangrove di sepanjang pantai Jepara dan Oemak. Seminar Sumberdaya dan Ungkungan Perairan Jepara. Kerjasama LON LIPI -Undip. 7 hal.
- Kartawinata, K., S. Adisoemarto, S. Soemodihardjo dan I.G.M. Tantra. 1979. Status pengetahuan hutan bakau di Indonesia. Seminar Ekosistem Huta Mangrove, Jakarta: 21 -39.
- Lear. R. and i Turner. 1977. Mangrove of AustraliE.. University of Queensland Press. 84 pp.
- MaCnae. W. 1968. A general account of the fauna and flora of mangrove swamps and forest in the Indo-West-Pacific region. Adv. Mar. Biol. 6: 73 - 270.
- Mueller-Dumbois. D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley & Sons, New York. 547 pp.
- Rahardjo. G., B. Hendrato. T.D. Wirutalingga dan Y. Hutabarat. 1980. Keadaan ekologis sumberdaya mangrove di pantai utara Jawa Tengah. Pusat Studi Pengembangan Sumberdaya Laut. PRP Undip, Semarang. 44 hal.
- Soerianegara. I. dan Inderawan. 1982. Pengantar ekologi hutan. Fakultas Kehutanan, IPB.
- Sukardjo, S. 1984. The mangrove forest in Bungin river Sanyuasini South Sumatra. Proc. As. Symp. Env. Res. Manag.: 121 -141.